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EDUCATION AND TRAINING OF THE GAS ENGINEER

THE schemes of technical education for the gas industry in France and Great Britain, their evolution and present position, were admirably outlined by M. Prégermain and Dr. Thorne in the papers they presented to the International Gas Union. It is a pity that our American colleagues did not describe their own schemes, particularly since technical education in every direction appears to occupy a more prominent position in the U.S.A. than in Europe. In France the classical tradition in education appears to give way very slowly to the modern tendency to early specialisation, a tendency in many respects to be deplored. The high standard of professional competence on a basis of sound scientific knowledge and good general education which is nearly always noted in the French gas engineer reflects great credit on the 'somewhat anarchic position' in which the profession counts within its ranks 'a goodly number of the self-taught.' The steps taken by the Association Technique du Gaz to cope with the new situation, in which the technique of gas manufacture and distribution tends to become a science, are of the greatest interest, though perhaps more suited to the greater degree of concentration in the industry in France than in our own country. Higher education in France is not generally specialised, and it is necessary for the young engineer himself to complete his education in the technique of the particular branch of engineering he has chosen to follow.

In 1929, the Association set up a cycle of instruction permitting young engineers to perfect themselves in gas engineering practice by studying all the major problems in the gas industry itself as well as in its relations with other industries. Addressed to engineers with at least two years' experience in the industry this Study Centre permits the acquisition within a relatively short period of knowledge which they would not be able to obtain by means ordinarily at their disposal without long years of assiduous and difficult work. The course is not only intended to educate technicians in gas manufacture, distribution, and utilisation, but to give its participants that education in the general principles of organisation which would fit them for the highest positions in the industry. Among the details of the scheme is the final seven days of visits to works in France and the neighbouring countries. As the number of students is limited to from 20 to 25 it is easy to see that this instruction can be very thorough. It is interesting to note also that the lessons are given not by full time teachers but by engineers in practice, each with his own point of view, representative of every aspect of gas engineering technique. And these lessons are supplemented by lectures given by outstanding men in the scientific and industrial world or in the gas industry itself. This curriculum has been found to give very satisfactory results. 'Gas Week' is another element in the structure of the French education scheme which excited considerable interest in the discussion. Since 1921 it has provided a sort of refresher course for technicians already engaged in the gas industry, in the form of eight lecture sessions on technical and commercial aspects of the industry and on new problems, and it includes two or three visits to works. All this apparatus of education seems to be concentrated in Paris, and while every effort seems to have been made to put it at the disposal of young engineers scattered over the country, there must be just the same problem as we have of the young man employed at the smaller works involving a journey of an hour or more to the nearest technical college. In France the student goes to Paris for a fortnight at a time. In Britain we are beginning to see the wisdom of releasing him for a whole day each week, a device which is probably sufficient to meet most cases.

The tradition of part-time education is very strong in this country. Dr. Thorne traced its interesting evolution from the Science and Art Department set up after the 1851 Exhibition. Mr. Dyde summed up present opinion in the sentence, 'it is obviously the better way for a student to undertake as much of his basic training as possible on a full-time basis, and to complete his specialised training on a part-time basis while in association and contact with the practical problems of his craft.' The evening courses now available at most technical colleges provide very well for this except for the objectionable features of evening study itself to which Dr. Thorne drew attention. A considerable advantage of replacing evening by day study is that it is possible to shorten the period required to reach the higher grade standard. Part time day study in mechanical engineering for instance has reduced this period from five to two or three years, and this would no doubt be the result if it could be applied to gas engineering. The range of subjects which the young gas engineer must study provides a great temptation to start too early with technical education. It is important that the foundation of good general education, in English, in elementary mathematics and in the fundamentals of chemistry and physics, should be well and truly laid before the superstructure of technics is begun. These subjects will generally be taken before leaving school. Industrialists should impress upon educationists that they need their prospective recruits to be trained in English so that the mother tongue can be used with confidence and facility as a means of expression with some approach to lucidity, simplicity, and euphony. No doubt such a training is facilitated by the parallel study of at least one foreign language. The mathematics should be, at this stage, theoretical rather than what has recently been called 'practical mathematics,' a subject in which the student has been encouraged to apply methods in the principles of which he is so often insufficiently grounded. And the chemistry and physics should be kept down to basic facts and principles, the teaching being aimed rather at the acquisition of a sound scientific attitude than that of information.

The small percentage of recruits to the industry who are university graduates must not prevent us from scrutinising their education and training too. They will emerge from a body of students beginning with applied chemistry or even general engineering, spending their final year, or a post-graduate year, in fuel technology, or even gas engineering proper. In this connection there is need to draw attention to the desirability of setting up chairs or lectureships in these subjects in several more of our newer universities. But the bulk of our recruits will still be part-time students, and everything possible should be done to encourage these students in the use of whatever educational facilities are within their reach. Dr. Haffner called attention once again to the educational value of the Junior Gas Associations. It is hoped that the area Boards will not overlook this point. Some undertakings have released their juniors to attend meetings and have paid their reasonable expenses. This surely should be common practice under the new régime. It has been pointed out that not only do the Junior Association meetings provide a training ground and a means of instruction for the junior himself; they also provide to the chief executive a show ground on which he can judge for himself the merits of candidates for promotion in the staffing of the industry. And, by the way, there is a wrong to be righted at least in some areas; Junior Association meetings should be arranged on working days and not encroach on the necessary time for week-end exercises and recreation in the open air.

Over all hangs the spectre of military service. When is the young man to put in this 18 months' soldiering; immediately on leaving school, and before the specialisation period, or after it? It is not likely that for many years to come we shall be released from the anxious consideration of this question. It is a pity, by the way, that our French colleagues, who must know much more than we do about its effects and the methods of dealing with them, did not tell us something about it. It will remain a duty to be done and perhaps the sooner, in the life of the individual, it is got over and done with the better.

DEMAND AND ANSWER

As a result of good service given by the gas industry prior to the war, helped undoubtedly by propaganda of educative value, there developed a very great demand for gas from all sections of the community, for domestic and industrial purposes alike. The war record of the gas industry was one of which any industry could be proud. Circumstances following the war have increased, not diminished, this call for gas service, as, indeed, statistics show. But these statistics do no more than point to the magnitude of the demand. Would-be customers—and this applies particularly to the use of gas for water heating—are frustrated at the outset by the staggering purchase tax on appliances. The tax is not only a stumbling-block to the customer; it is causing the utmost hardship among appliance manufacturers. As we see it, the position is perilous. There is another aspect of the answer to the demand for gas service, and that is the capacity of the industry to supply the gas required during periods of peak demand in the winter. More than a few look askance at the development of the domestic gas heating load, and, indeed, a considerable proportion of the programme at the recent conference of the International Gas Union was devoted to discussion of various problems of the peak load. In this regard the paper by Mr. F. M. Birks was of the utmost significance, and it pointed to a greater use in future not only of the carburetted water gas process but of the generation of gas from oil alone. It is some time since that paper was prepared, when the author suggested that the total gas-making capacity of a works might be made up in the following approximate proportions: Coal gas plant, 50 to 65%; carburetted water gas plant, 40 to 25%; oil gasification plant, 10%. Since then further emphasis has been laid on the gasification of oil. Even in his paper Mr. Birks said: 'The three processes of gas manufacture may each have a place in the gas industry for a number of years to come, but it may prove advantageous to use an even greater proportion of oil-consuming plant than is at present customary.' And he added: "This will necessitate the facility of adjusting appliances in the field to a mean setting to burn easily and efficiently gases with the widest range of characteristics.' Mr. Birks had no hesitation in putting this problem as one of the most important objects of research today.

The problem is highly complex. Over-riding everything the gas industry must aim at the complete answer to this clamant call for gas service. Labour conditions have undergone a complete change within the past decade, and this single factor has or should have a large bearing in the formulation of policy. Mr. C. H. Chester, President of the Institution of Gas Engineers, has pointed out that when residual markets were good, coal gas production increased; in fact, he argues, the policy of the industry has wavered with the success of the by-product business. British practice, as previously conceived, operated carburetted water gas plant for only half the period illustrated by Mr. Birks as the economical optimum. Provided oil supplies could be reasonably assured they would tend automatically to control the coke market with more stability, and the gas industry would tend more and more to become a one-fuel industry. This conception is not at variance with the production and sale of satisfactory solid smokeless fuel and still better appliances for burning it. Both solid and gaseous fuel will be needed for some time to come—probably for a long time—to cope with the winter space-heating demand. But we do think that a bolder attitude is called for on the expansion of gas for space heating to meet present and future public demand.

The winter of 1946-47 was exceptionally severe. The gas industry put forward valiant efforts to meet the situation and was to an extent successful; but the approach was in the nature of a compromise. The methods adopted were to an extent discussed at the International Congress. Gas pressures were greatly decreased, with consequent lessening of the space heating load for the simple reason that sufficient gas for comfort was not made available at the consumers' appliances. Obvious effects of pressure reduction on domestic supplies were mentioned in the I.G.E. report at the congress, 'Methods of Maintaining a Gas Supply, Particularly to Priority Consumers, in Times of Gas Shortage'—a long drawn out and clumsy title to a tale of worthy compromise. The report told us that reduction of pressure does not greatly affect the use of gas for cooking—a highly optimistic comment on service, a comment entirely ignoring the views of the housewife. Storage water heaters, the report went on, will operate at low pressures, but—and this surely is imaginative—'the recovery time is much longer and a higher total gas consumption results.' As for instantaneous water heaters, these 'become practically useless when pressures are considerably reduced.' And so on (folio 5, I.G.U./5). The report in question is, of course, an admission of failure. What we need is a policy which will yield happier results. The demand of which we write calls for a firmer answer.

OPEN TO INSPECTION

The enterprise shown by the South Suburban undertaking in designing a trailer-showroom for sales and displays on outlying large estates, details of which were given in last week's *Journal*, has occasioned considerable interest in what is, as far as we know, the first post-war venture of this kind. We have now been informed that by the courtesy of the South Eastern Gas Board the trailer unit will be on display at the undertaking's sports ground, adjacent to 21, Bell Green, Lower Sydenham, S.E.26, from 2 to 6 p.m., from Aug. 29 to Sept. 2.

OVERSEAS STANDARDS

It appears that it is not sufficiently well known that the British Standards Institution acts as the agent in the United Kingdom of all oversea national standards organisations. At the present time, when every possible avenue for export is being explored, many concerns write direct to standards organisations overseas, only to be referred to the B.S.I. Time and money will be saved by applying to the British Standards Institution, 24/28, Victoria Street, London, S.W.1, for all information regarding standards, both home and overseas.

THE QUESTION OF MAINTENANCE

Great stress has been laid during recent months on the methods which the gas industry in general and individual gas undertakings in particular should adopt in a realistic attempt to meet the demands of domestic consumers during the winter months. On the other hand, far too little emphasis has been given to the question of the maintenance of consumers' gas appliances to ensure that the gas burned in them will be used efficiently and will give good service. During the war years the opportunity to maintain appliances properly did not exist. But it is now over four years since the war was brought to an end, and to the best of our knowledge little or nothing has been done in this period as far as maintenance is concerned. The word 'nothing' rather than 'little' applies to our own experience (North Thames). There is something seriously amiss about the gas industry's policy in this respect. It is, to say the least, ironic that those at the producing end, at the gasworks, should be doing so much to produce the gas needed for satisfactory service, and talking so much about their deeds and hopes, the while, no one seems to care very much how the gas is used. Certainly much of the apparatus in consumers' premises is woebegone and wasteful. Some of it is even dangerous. Before the war one of the strongest planks of the gas industry platform was its maintenance service. Nowadays that plank is faulty and rotten, and the consumer suffers. Why not an 'Operation Maintenance' during the coming autumn? Or will such excuses as lack of labour, lack of materials, shorter hours, and so on, be put forward? The policy of *laissez faire* in this regard is simply an admission that the gas industry is careless in its custom, is indifferent to fuel wastage, and is willing to court and countenance danger.

OPPORTUNITIES PRESENT THEMSELVES

There has been delay in the work on new satellite towns, caused by a ban on capital expenditure and by shortages of labour and material, but this work is now being accelerated. Among several schemes, it has been known for long that about £150,000 would be allowed to Stevenage, about £50,000 each for Hemel Hempstead and Harlow, £24,000 for Crawley, and £3,750 for Aycliffe. Information concerning this became public knowledge more than a year ago, and we asked the gas undertakings who would eventually cope with gas demand resulting from these developments to let us know something about their plans. At the time—twelve months and more before the gas industry was nationalised—some of the undertakings concerned felt bound to adopt a hush-hush policy, which precluded us from publishing a few innocent details which could have hurt nobody but would certainly have added to gas industry prestige. Generally in Great Britain we deplore iron curtains, and our sincere hope now is that no such thing may descend to cut us off from gas practice and development and that no-one will bid us 'Ask your dad.' Be that as it may, we have learned from sources other than gas undertakings that 20 aluminium houses are being erected at Stevenage; that at Hemel Hempstead progress has been made with 233 houses with all services; that at Harlow 102 houses with all services are nearing completion; and that Crawley has 34 houses, of which a few are occupied. In this scheme a factory is being erected in the first section of the new industrial area. What intrigues us most is that at Aycliffe a scheme for 306 houses has been approved, erection of which is proceeding, and that a scheme for district heating has been approved in principle. The foregoing constitute the first series. There are also Welwyn and Hatfield; Basildon, in Essex; Bracknell, in Berkshire; Cwm Bran, in South Wales; Corby, in Northamptonshire; Peterlee, in Northumberland. All present opportunities for gas. Each presents opportunities for propaganda in the correct sense of that word.

Letter to the Editor

Price of Coke Oven Gas

DEAR SIR,—I have only recently had the opportunity of reading your report (*Journal*, July 13, p. 166) of a speech made by Colonel W. M. Carr in Manchester recently in which he referred to the price of coke oven gas. I would like to ask whether it really is in the best national interests that the gas consumer should be provided with artificially cheap coke oven gas when this entails coke being sold to the blast furnaces at an equally artificially high cost, meaning dearer iron and steel with all that this entails to industrial costs all over the country.

The transfer cost of coke oven gas in a steelworks is about 5d. to 5½d. per therm for unpurified gas, this being somewhat less than the price of fuel oil or creosote pitch which, however, have certain advantages that gas does not possess—including luminosity of flame and ease of storage—and I am unable to see how the gas industry can expect to receive gas from a steelworks for less than this.

In the case of the merchant plants gas has to be sold to the gas industry which appears to expect the gas at about 2½d. to 3d. per therm. This can only be done at the expense of coke, and it is a matter of simple arithmetic to see what difference this makes to the price of coke to heavy industry.

As far as I can see, Colonel Carr is still thinking of 1945, and is basing his arguments on a paper read by two of his then technical staff at Cardiff on a gas grid for South Wales. I would like him to take, say, a coke oven plant carbonising 1,000 tons of coal per day, complete with producers, purifiers, &c., and costing about £2 mill.; take the current price for domestic coke which is somewhat less than that of furnace coke; take an approximate load factor, operating and capital charges—and see what the present price of gas from a new plant really is.

As far as the steel industry is concerned it would be disastrous if the gas industry took over the merchant coke oven plants, since it is obvious from Colonel Carr's speech that this would mean cheap gas and everything else dear—but immediately any industry is nationalised it has to start empire building (if it can) and let the consequences go hang.

Yours faithfully,
STEEL.

Aug. 16, 1949.

Personal

Long-standing business associates of Mr. R. J. GREGG formed the nucleus of an informal cocktail party held on Aug. 19 to wish him success in his new appointment as Publicity Officer of the Gas Council. The gathering was held at the offices of the Architectural Press, Ltd., at the invitation of Mr. V. V. Tatlock, in whose absence Mr. Frank Yerbury officiated.

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In addition to the Chairman, Councillor E. BAYLISS (Islington, N.7), the following members have been chosen by the Minister of Fuel and Power to serve on the Gas Consultative Council for the North Thames area: Mr. W. N. BACON (New Southgate), Councillor G. H. BAKER, J.P. (High Wycombe), Councillor Mrs. E. M. BRACE, J.P. (East Ham), Alderman G. C. CARTER, J.P. (Stoke Newington), Councillor G W. CHANDLER (Greenford), Mrs. A. CROWN (Leytonstone), Mr. B. M. DODDS (Cookham Dean, Berks), Mrs. K. M. GAMBLE (Walthamstow), Councillor Mrs. W. KADER (Queen's Gardens, W.2), Mr. G. P. LITTLE (Ashford, Middlesex), Mr. A. L. MARDEN (Osram G.E.C. Glass Works), The DOWAGER LADY NUNBURNHOLME (Cottesmore Gardens, W.8), Mrs. J. PHILLIPS (Westbourne Grove, W.2), Councillor H. M. ROYLE (Southend-on-Sea), Alderman C. P. RUSSELL, J.P. (New Coventry Street, W.1), Mr. H. J. SCOTT (J. Lyons & Co., Ltd., Cadby Hall, W.14, and Surbiton), Councillor Mrs. A. TOPPING (Hanwell, W.7), Mr. W. H. VENNER (Brentwood), Mr. A. H. N. WELLS (A. Boake, Roberts & Co., Stratford, E.15, and Finchley, N.3), and Councillor D. WRAY (Chigwell).

Obituary

Mr. GREVILLE J. WHATLEY, A.M.I.C.E., M.INST.GAS E., died at his home at Streatham Hill, on Aug. 15, at the age of 68. He was for many years technical assistant to the late Mr. Arthur Philips; from 1919 he was technical assistant to Sir George Evetts and took over the practice when Sir George retired from consulting work in 1939, and in January, 1948, he entered into partnership with Dr. M. Barash. Mr. Whatley had for over three years been unable through illness to attend his office at Palace Chambers, Westminster, although he had continued to do a certain amount of work at home. The office at Palace Chambers will close down on Sept. 29.

A STUDY OF PROGRESS IN THE DOMESTIC UTILISATION OF GAS*

By A. R. BENNETT, M.Sc.,
Research Manager, Radiation Ltd.

BEGINNING as a hole in the end of a pipe from which gas issued and burned as best it might, gas appliances have evolved into assemblages of highly developed components to the detailed design of which specialists in many branches of science and engineering have made their contributions. As everyone knows, coal gas was first used for lighting, and it was, therefore, the luminosity of the flame rather than its heat output which constituted its most valuable characteristics in the economy of the day. The passing in 1882 of the first Act relating to electric lighting stimulated the interest of the gas industry in others fields of utilisation. With the introduction of the gas furnace and the gas engine, its interest centred for a time on the industrial load. Domestic heating and cooking were not taken seriously except for a few enthusiasts who no doubt appeared as cranks to many of their contemporaries. Appliances developed by trial and error rather than on the basis of even the most elementary calculation. Starting as analogues of existing solid-fuel heating and cooking devices, the appliances gradually progressed towards more functional designs, and less was conceded as time went on to traditional preferences and prejudices. Criticisms of 'fumes' associated with gas appliances were general throughout the Victorian period, yet no satisfactory or sensitive method of detecting leakage of products of combustion into a room was developed until 1912, and the technique for measuring completeness of combustion was not evolved in practical form until 1926.

Radiant and Convected Heating

During the latter 19th and early 20th centuries much controversy raged around the relative merits of radiant and convected heating. There is, however, no indication of any recognition that both types of heat could vary in quality as well as quantity. Convected heat was often associated with a small volume of air at high temperature leading to unpleasant physiological effects owing to the low relative humidity, while in radiant appliances the radiating media used were often operated at a low temperature and yielded a large proportion of long wave-length energy which is now known to be undesirable from a physiological standpoint. It was, however, recognised that a bright fire had psychological advantages. Wire mesh was used as the radiating element in a gas fire in 1877 and was reported to give a very bright and cheerful effect, but platinum was the only material then known which would withstand the temperatures attained for any length of time, and even in those days was too expensive to permit of widespread use. Asbestos fibres were also used, but suffered from rapid disintegration. This was, however, figuratively if not literally, a flash in the pan and wire mesh quickly disappeared from the scene in favour of refractory ball fuel and cast iron frets which were piled up in a more or less haphazard manner, the gas being allowed to burn in the interstices. While these devices were possibly satisfactory in the hands of the better informed manufacturers, there is no doubt that the general effect was poor and contributed to the disrepute into which this class of appliance fell in many quarters. In the belief that convected heat was inherently undesirable, efforts were made to maximise radiant energy at the expense of convection. The first step towards a rational 'scrubbing' system was taken when the columnar radiant was introduced at the turn of the century. From this point onwards the importance of 'tailoring' the solid structure to the flame was realised and the way was open to the simultaneous attainment of both reasonably complete combustion and reasonably high efficiency. That the gas fire still had many faults, however, was evident from Brearley's report of 1909, which stressed the importance of increasing radiant output and commented on the undesirability of products of combustion escaping into a room. These strictures might have been more forceful had Brearley had to his hand the technique for the accurate assessment of completeness of combustion.

The early development of the gas cooker and the opposition which it aroused is an even more striking example of pure empiricism unrelieved at any point by a scientific approach. Cooking by gas had been envisaged by Winsor in his early patents and had been put into effect on a limited scale and with simple apparatus in the first half of the 19th century. Strong prejudices were, however, encountered regarding the possible contamination of food by 'fumes.' The early appliances derived naturally from current practice in coal-fired grates and ranges, and considerations of temperature distribution and thermal efficiency were at that time remote from the thoughts of the designers. Specialisation of function into oven, griller and boiling-ring was introduced at an early stage and during the latter half of the century many now familiar devices made their appearance in the patent records. In the latter period the reduction of heat losses had become a design factor, but we find even Thomas Fletcher arguing in 1883 that a solid cast iron box was preferable to a sheet metal oven lagged with slag wool. The advances were primarily the result of mechanical ingenuity and of the introduction of new materials and manufacturing techniques rather than of improvements based on quantitative scientific study of the processes involved.

Gas Cooker Design

Although automatic methods of controlling the temperature of the oven enclosure were foreshadowed in various 19th century patents, and the discovery of the non-expansive alloy 'Invar' was made in 1898, it was not until 1904 that the oven thermostat as such was introduced, and its commercial exploitation in Great Britain did not take place until about 20 years later. Progress in this particular direction was rather more rapid in the United States of America. Automatic ignition made its first appearance in 1906, but reliability of operation is a relatively recent achievement, resulting from a close study of the numerous factors involved.

By the early part of the 20th century, gas cooker design in Great Britain had become stereotyped to a considerable degree, the better quality appliances incorporating oven lagging, vitreous-enamelled linings and panels, removable and replaceable oven furniture, burners and bars. Cast iron was the predominant structural material. Provision for adjustment of air and gas was made on some models. During this period cooker manufacturers had developed their own methods of assessing cooker performance, but following the adoption of the thermal basis for the sale of gas the need arose for some generally acceptable standards, and as a result of this the Institution of Gas Engineers set up a Committee to investigate and make recommendations on test methods. The recommendations of this Committee have been followed by the development and adoption of the various standard tests under the ægis of the British Standards Institution.

Water Heating Appliances

The development of gas water heating appliances has followed a fairly uneventful course since the very early applications of gas for this purpose. Following an initial stage in which the heat from the burning gases was applied directly to the bath or to the vessel containing water to be heated, the instantaneous heater or 'geyser' was soon recognised to be a more convenient and adaptable form of appliance. This type of heater first made its appearance in 1868, and from the outset a relatively high thermal efficiency was attained as condensation was permitted, and hence practically the whole of the available heat could be abstracted from the burned gases. There were, of course, many other respects in which the early designs were unsatisfactory, little attention having been paid to completeness of combustion or to the provision of a reasonable margin of safety against overload conditions. Most of the early appliances were operated fluelessly, and considerable time elapsed before the down-draught diverter was used.

The general trend of development over the last half century has been to reduce thermal efficiencies in the interests of obtaining a wider margin of safety in regard to combustion. With the abandonment of the condensing principle, problems of corrosion and heat transfer have to some extent been rendered more acute, and much experimental work in this field has been connected with the choice of suitable non-corrosive materials and the avoidance of conditions of concentration and temperature in flue gases under which corrosion is liable to take place.

Much mechanical ingenuity has been devoted to the design of control devices for regulating water temperatures and avoiding the dangers of explosive ignition. Thermostatic devices were applied to water heaters rather earlier than to cookers, and their characteristics in controlling the rate of heat input to the water have been the subject of more detailed study. It is, however, recognised that the varied conditions of installation and usage render

* From a paper presented to the 4th Congress of the International Gas Union, London, June, 1949

it difficult to assess practical performance under laboratory conditions. Increased attention has therefore been given to devising schedules of test to simulate average domestic usage.

The casual observer often gets the impression that a retrogression has occurred in the thermal efficiency of gas appliances. Although the disappearance of certain classes of appliance, such as the condensing 'geyser' and heating stove, has reduced the highest efficiencies attained in gas appliances, and with good reason, the gradual improvement of accuracy in test-methods has eliminated much optimistic bias in quoted results. The attainment of satisfactory combustion under severe conditions of overload has also involved some lowering of efficiency standards in most types of appliance. This is bound up with dimensional limitations which experience has shown to be desirable. After a period of concentration on appliance efficiency under laboratory conditions in which methods of test were developed which sometimes tended to give a misleading impression of appliance performance emphasis is now moving towards a closer relationship between efficiency criteria and conditions of usage (*e.g.*, reversion to the use of test-rooms; but with control of external temperature for comparisons of heating appliances of widely different types, especially where comparisons of different fuels and different heat-distribution systems are involved). Although the modern developments of this technique have not yet yielded any considerable volume of data, there is reason to hope that such tests carried out with accurate instruments and with close and, where necessary, statistical control, will give the answer to much ill-founded criticism of gas appliances due to misinterpretation of bench efficiency figures.

Basic and Incidental Processes

The general state of knowledge on the related phenomena of ignition and combustion has recently been reviewed in the Gas Research Board's Symposium on Combustion Research. In his contribution Dr. Harold Hartley has made particular reference to the gaps in our knowledge as affecting the usefulness of the academic study of combustion phenomena to the designer of combustion appliances.

In spite of the amount of work being done on the ignition process there seems to remain a considerable diversity of opinion on the details of the mechanism. Recent work by von Elbe and others has clarified the energy relationships involved, and a further study of the concentration of effective energy necessary to cause ignition by different methods should throw much light on the mechanism, since the number of stages between the initial generation of energy and the final establishment of flame varies from one method to another. Of the eight methods of igniting gas-air mixtures to which reference is made in the above-mentioned symposium, five have been incorporated in practical gas appliances, and experience with these shows that the ideal method of ignition from a practical standpoint has yet to be developed. For reliability and simplicity the permanently burning pilot flame is the most attractive arrangement, especially as it lends itself to combination with a safety device as is general practice on water heaters and on ovens fitted with clock control. There is undoubtedly a considerable field for further development of ignition units, and a fundamental study of the underlying processes could make a major contribution to the solution of the practical problem.

In the study of the combustion process the introduction of physical methods of investigation has enabled more rapid progress to be made than was possible by the almost purely chemical approach of the 19th century, although the picture of the mechanism derived from flame spectra, for example, is not as yet completely reconcilable with that based on chemical and other evidence. Much of the work of the investigators of combustion processes in flames has hitherto been rather negative so far as its practical applications are concerned.

One contribution which is of value to burner designers is the recent clarification of factors affecting flame stability, permitting greater flexibility in burner performance to be attained. Academic work on flame speeds is of little value to the practical designer, who is concerned with mixtures of gases covering a wide range of composition. The need for flexibility of burner performance precludes the achievement of optimum results on any one gas.

Brief reference must be made to the advances in experimental technique which have facilitated combustion work. Apart from the greater variety and accuracy of temperature- and flow-measuring instruments, many physical measurements are now relevant to a field which half a century ago was considered the exclusive territory of the chemist. In addition to flue gas analysis the gas appliance designer often needs to know in detail the analysis of the gas reaching the appliance. The Gas Light and Coke Company's modification of the Bone and Newitt apparatus is very generally used, but more recently the soap-bubble flow meter has been adopted by Gooderham for this purpose, enabling a virtually continuous and instantaneous check on composition to be made. While it would be difficult to improve on this apparatus for rapidity and directness, its use is hardly justified where only occasional analyses are required. For special purposes (*e.g.*, separation of close homologues or isomeric compounds), distillation at low temperatures has been used both in Great Britain and in the United States of America, and in the latter country commercial gas analysis apparatus based on this principle are available.

One of the biggest single steps in the application of scientific methods to gas appliance development was the introduction in 1926 of an accurate method of assessing carbon monoxide concentration in products of combustion. This was based on the now well-known iodine pentoxide method, of which there have been several variants, and which has been adopted as the standard method in Great Britain and other countries. The rather less sensitive but more rapid method of catalysing the CO to CO_2 and measuring the resulting temperature rise has been exploited in the Drager and Katz instruments using Hopcalite or similar mixture of active oxides to promote the reaction. It is sometimes overlooked that in this method any free hydrogen in the gases is also catalysed and is recorded as CO.

The subject of combustion research cannot be left without some reference to sampling technique, defects in which have undoubtedly been the cause of many inaccurate conclusions regarding gas appliance performance. While it is often possible to introduce devices to promote the mixing of gases before sampling, there are certain tests (*e.g.*, the measurement of CO_2 in the primary flues of water heaters) for which it is impracticable to obtain a homogeneous mixture before sampling, and the sampling arrangements must therefore effect the necessary averaging of the non-uniform stream. This point of technique arises in the testing of draught diverters attached to appliances, and the author now inclines to the view that some alternative method of measuring the air flow through the appliance and the primary flue is preferable to the CO_2 method, as in other cases of flow measurements in ducts.

While heat transfer from streams of hot gases to solids has been extensively studied from an engineering standpoint for many years, and more or less successful attempts have been made to systemise the data from a physical standpoint, published work on heat transfer from flames is scanty and is as yet insufficient to enable conclusions to be drawn as to the relative importance of some of the factors concerned. Some unpublished work carried out by the author in 1939 suggested that the heat transfer from flames to solids immersed in them was proportional to the temperature difference and in this respect followed the usual laws for forced convection. The accuracy of the conclusions was limited by doubt as to the exact values for the emissivities of the solids used. Later work by Kilham, using more refined methods of temperature measurement, has, however, supported the above conclusion, but contrary evidence has more recently been produced in the case of H_2–air mixtures. Until this fundamental point is settled the theoretical basis of heat transfer in most gas appliances cannot be well and truly laid.

(*To be continued*)

Diary

Sept. 2.—**Northern Junior Gas Association:** 'The Production of Petroleum Products, with particular reference to Lubricants,' Ian A. Howden, B.Sc., Divisional Lubricant Supervisor, Newcastle Division, Shell-Mex and B.P. Ltd., Grand Hotel, Sunderland, 2.30 p.m.

Sept. 6 and 7.—**Irish Gas Association:** Annual Meeting. Alliance and Dublin Consumers' Gas Company's Lecture Theatre, D'Olier Street, Dublin.

Sept. 8 and 9.—**Combustion Engineering Association:** Conference on the Rational Allocation of Coal, Palace Hotel, Buxton.

Sept. 8.—**Institute of Welding:** Visit to the Engineering and Marine Exhibition, Olympia.

Sept. 12-16.—**Association of Public Lighting Engineers:** Annual Meeting, Llandudno.

Sept. 12.—**Women's Gas Council:** Executive Committee Gas Industry House, 1 p.m.

Sept. 13.—**Women's Gas Council:** Headquarters Members. Visit to the Cavendish Works (De La Rue). Leaving Gas Industry House, 2 p.m.

Sept. 15.—**North British Association:** Annual General Meeting, Music Hall, George Street, Edinburgh.

Eight Words were accidentally omitted from the summary in the *Journal* last week (page 425) of the address which Mr. T. Mervyn Jones, Chairman of the Wales Gas Board, gave to the Nalgo Summer School at Exeter on July 16. Having paid tribute to municipal achievement in gas service and other spheres, Mr. Mervyn Jones referred to certain unfortunate tendencies, and said (the words in italics having been omitted through a proof-reading error from our version of his address): 'Would I be wrong in saying that there were instances of possibly a too scant regard to *commercial factors and a too high regard to* the transient susceptibilities of the public.'

BUILDING RESEARCH PROGRESS IN 1947

HEAT REQUIREMENTS OF HOUSES

THE work carried out by the Building Research Station during 1947 is reviewed in *Building Research, 1947*, published this month for the Department of Scientific and Industrial Research by H.M. Stationery Office (2s., by post, 2s. 2d.). In the first part of the report the Building Research Board records the outstanding features of policy and programmes during the year. Attention is drawn to the fact that the Station's concentration of effort on urgent short-range problems cannot be continued indefinitely without seriously affecting the basic and more fundamental research on which short-term work ultimately rests. Mention is made of two steps that will help the Station to take account of local experience and practice—the decision to open a branch of the Station in Scotland, and the appointment during the year of 47 honorary observers in different parts of the country. The second part of the report surveys progress on the main items of the various programmes, together with references to the results published during the year.

A programme of full-scale heating trials continued during 1947 and was considerably expanded both in eight houses at Bucknalls Close and 20 houses at Abbots Langley. The technique of recording the internal climate of houses by the use of remote indicating instruments enabled complete records of house temperature to be obtained at Bucknalls Close during the winter of 1946-7 when the houses were occupied by tenants. The amount of fuel consumed for space heating, topping-up, and cooking was also determined and a report of the results obtained was published in the Journal of the Royal Institute of British Architects for October, 1947. The results confirm the findings of the earlier work during the unoccupied phase, namely, that the economy of fuel resulting from insulating the houses justifies considerable capital expenditure on insulation.

Extending Scope of Measurements

The experiments are continuing in these houses and arrangements are in hand for extending the scope of the measurements. The primary object of this work is to enable the various factors in heat balance equation to be determined and to make a scientific study of the various factors involved in heat loss from dwellings in order that the results may be extrapolated to climatic conditions existing in other parts of the country.

In the earlier work no direct measure of ventilation in the houses was available. The direct determination of this variable is of considerable importance since the loss of heat by ventilation forms a substantial part of the total heat loss, particularly in well-insulated houses where the conduction losses have been reduced. In order to carry out measurements during the occupied phase a new technique of measuring has been devised. Copper tube, with outlet jets at intervals, is placed at various levels in all rooms and is connected to a central position in the tool shed. A mixture of helium and air is pumped through these tubes and subsequently the air in the room is sampled at interevals through the same tubing. The composition of the gas is determined by katharometers and by computation the ventilation rate is determined. So far four of the eight houses have been equipped for these measurements.

Another factor which has not so far been measured in these trials is the amount of fuel consumed in the use of hot water for domestic purposes. A 'B.Th.U. meter' consisting of a thermostatically-controlled mixing valve and hot-water meter, has been developed. Two of these have been installed in each house to measure the heat used in providing hot water in the kitchen and in the bathroom.

In order to determine the efficiency of the boilers which provide hot water for domestic use and for the heating panels, arrangements have been made for sampling of the flue gases.

The 20 houses at Abbots Langley were completed during the summer of 1947. These houses are all of the same floor area but not the same plan. The majority (16) are of the 'through living-room' type with a dining space off the kitchen; the remainder have a kitchen-living-room and a parlour. On the first floor the differences in planning are small, each type having three bedrooms and a bathroom. All the houses have the same degree of insulation though the method of achieving the insulation in the walls varies. In these houses there are 19 different heating systems, one system being repeated in order to study the effect of a different exposure. The systems may be considered under four main groupings. In that group satisfying what may be described as pre-war standards, the living rooms are heated but the bedrooms are not. Kitchens and dining spaces get their heat from the cookers or domestic hot-water heaters in the kitchens. The halls are unheated. In the group of houses with 'improved standards,' background and topping-up heat is supplied to the living-room and to one or all of the bedrooms. The kitchens again get their heat from the cooker or in some cases from a heating appliance in the kitchen. The halls are generally heated. In the group of houses with 'full house heating' all rooms are heated. The remainder of the houses form a miscellaneous group which includes the kitchen-living-room type of house having solid-fuel cookers and/or combination grates.

Fuel Economy

The primary object of the experiments with these houses is to obtain information as to the suitability of heating systems from the point of view of practicability, amenity, and fuel economy. Any study of such a broad nature as this involves the determination of many variables; for example, capital cost, running cost, cost per degree day, house warmth and comfort, cleanliness, manageability and so on must be studied. This involves the measurement of such physical factors as the amount of fuel consumed, internal and external temperatures, optical reflection coefficients of walls and air movement. From the point of view of generalising the results these measurements must be supplemented by determination of the ventilation rate, meteorological conditions and losses of heat either by the flue or in the ash.

As with the trials at Bucknalls Close the work falls into two parts. In the first place the houses are untenanted, and subsequently tenants will move in and the measurements continue using remote indicating instruments. The unoccupied phase commenced on Sept. 28, 1947, and the houses were maintained according to a routine during the winter of 1947-48. This routine took account of the likely thermal habits of a family consisting of two adults and two children of school age; in other words it covered all the factors which may be expected to influence the amount of fuel consumed such as room temperatures, cooking, hot-water usage and curtain drawing.

Studies at the Unoccupied Stage

During the unoccupied stage many points of interest have been studied which it is not always possible to investigate when the houses are tenanted. For example, detailed measurements of temperature and air movement throughout living-rooms have been taken. The effect of convection ducts on sound transmission in houses and also rate of discoloration of the interior decoration have been investigated. Measurements of ventilation rate have been made using mobile equipment.

Extensive plans have been made for equipping all the houses with instruments so that as much information as possible can be obtained when the houses are occupied by tenants. All houses have been connected by multicore cables to two central recording huts. Multipoint recorders in these huts will enable measurements to be made of temperature in all rooms in all houses. In addition the same recorders will be used for measurements of humidity in certain rooms such as bathrooms and kitchens and in some cases the extent to which windows and doors are open will also be recorded. All the houses are being equipped with copper tubing so that ventilation rates can be measured when they are occupied. In addition to these recording instruments, all gas and electrical appliances are being provided with meters and B.Th.U. meters are being installed for measurement of kitchen and other hot water usage. The meteorological conditions are being measured by standard equipment.

When the houses are occupied records will be available at half-hourly intervals of some 700-800 different parameters, so that the digestion of the data becomes a major feature of the work. Arrangements have therefore been made for all data to be transferred to punch cards for ease of analysis. The scale of the experiment is such that some years will necessarily elapse before it is finally concluded, but papers covering particular aspects of the work will be published at suitable intervals and serve as progress reports. In all, this work is now being carried out in 28 houses, covering two major variables in house heating, namely, thermal insulation and the heating system adopted, and it represents the most comprehensive experiment of its type being carried out anywhere in the world.

Heat Transfer Problems

Towards the end of the 1946-47 heating season, it was found possible to re-commence measurements of the thermal transmittance of walls in the Wall Laboratory. Further observations on the same walls were made in the latter part of the year. Of

particular interest are the provisional data for an 8 in. wall of dense concrete (1 : 2 : 4 gravel aggregate). The thermal transmittance of the wall is about 0.60 B.Th.U./sq. ft. hr. °F.; and the conductivity of the concrete is 11.5 B.Th.U. in./sq. ft. hr. °F. This value is in marked contrast with some earlier determinations of the conductivity of concrete (for which k = 7.0) to be found in the literature, but is in close agreement with the most recent values reported by the National Physical Laboratory, and with those found in other countries.

The study of the influence of the thermal environment on comfort and on physiological reactions, which is being carried out by Medical Research Council workers in the controlled temperature room at the Station, was directed first to the influence of various flooring materials on the temperature of the feet and on comfort.

Frequent references to the effects of cold or warm walls on comfort appear in the literature, but precise data showing these effects are not numerous. In the latter part of the year preparations were made for an intensive study of the subjective and physiological effects of warm and cold walls on sedentary persons, and the investigations are now in progress. Members of the staff of the Station were invited to take part in the tests as experimental subjects, and 130 persons volunteered. The intimate co-operation between the staff of the Station and that of the Medical Research Council has already had an important effect in the development of the studies.

FLAME MATCHING BURNER

ADJUSTMENT OF BURNERS UNDER ACTUAL CONDITIONS

THE purpose of a new flame matching burner developed by the North Thames Gas Board is to facilitate the adjustment of aerated burners under the actual conditions of gas supply on the premises at the time of the fitter's visit.

For reasons given later, the gas supplied, while always satisfying the legal requirements in regard to calorific value, &c., may differ from time to time in a way which affects the cone height and behaviour of a bunsen flame. It is therefore important that burners shall be adjusted in such a way that these changes affect the performance of the appliance as little as possible.

The flame matching burner is of the greatest assistance in adjusting appliances to satisfy this general requirement. The burner, complete in case, is shown in Fig. 1. The burner withdrawn from case, ready for use, is shown in Fig. 2.

Continuity of an adequate supply of gas, especially during cold weather and periods of peak demand, is of the utmost importance to both domestic and industrial consumers alike.

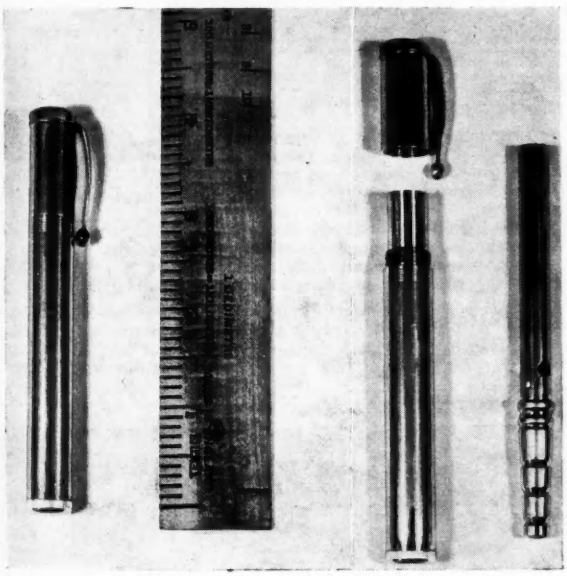


Fig. 1 *Fig. 2*

Unlike electricity, the fact that gas can be stored permits, under normal conditions, steady working of the gas-making plant; the stored gas meeting the usual variations in demand. During peak demands on the coldest days the flexibility of the gas manufacturing process also permits of the use of auxiliary plant and processes which can be brought into operation at comparatively short notice. These processes are particularly valuable at the present time because of the damage to plant sustained during the war, shortage of materials, &c., and especially as new plant takes considerably longer to obtain than was the case under pre-war conditions.

The gas from these auxiliary processes can be mixed with normal gas in any required proportions so long as the legal requirements, in regard to calorific value, &c., are satisfied.

As previously indicated, the behaviour of aerated burners when operating on 'mixed' gas, may be somewhat different than would be the case for the same burners when used under precisely similar conditions on 'normal' gas.

In general, if normal and mixed gas be supplied in turn to a given burner under similar conditions of pressure and adjustment, the normal gas will usually produce a flame with a somewhat longer cone than that for the mixed gas or, put in another way, the flame for the mixed gas approaches more nearly to the back fire condition.

Gas which produces a lambent flame with a long cone is sometimes referred to as 'soft,' whereas gas which results in a shorter cone is spoken of as 'hard.'

Two important requirements must, however, be satisfied if an appliance fitted with aerated burners, is to work satisfactorily under district conditions when supplied with either 'hard' or 'soft' gas. These are as follows:—

1. The appliance must be designed to operate satisfactorily on either normal or mixed gas.
2. The appliance must be correctly adjusted for the gas supplied at the time the appliance is fixed or maintained.

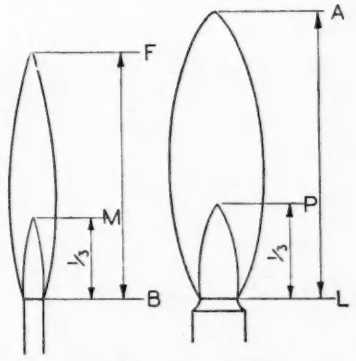
The first is clearly the responsibility of the appliance maker but the second is that of the fitter.

For some time it was customary on the area of supply of the Gas Light and Coke Company to have a cone height burner in operation at several service depots. By inspecting the cone height of this burner before leaving the depôt, the fitter could see whether the gas supplied on the day in question was 'hard' or 'soft' and the appliances were therefore adjusted accordingly.

While this was helpful in adjusting appliances according to the gas characteristics, there is little doubt that this procedure left a good deal to be desired and, and in consequence, the flame matching burner has been introduced.

Advantages of the Burner

The burner complete in its case is only a little larger than a fountain pen and can be carried in the waistcoat pocket. It will supersede the cone height burner operated at the depôt, since, in the case of the latter burner, the fitter is unaware of any changes in gas characteristics which may occur during his absence from the depot. Moreover, it is not invariably the case that the source of supply at all times to the particular premises is the same as that to the depot. The great advantage of the flame matching burner is that it can be connected to the actual supply to the appliance



Flame Matching Burner *Appliance Burner*

Fig. 3

at the time it is being adjusted and further, the flame from the matching burner is a direct visual aid to correct adjustment.

Each burner has been inspected in order to ensure that it conforms with the specified dimensions. The burner can only serve as a reliable guide if these dimensions remain unaltered. *The burner must be treated with the greatest care and should only be used for the purpose for which it is intended.*

Simplified instructions regarding the use of the burner are:

1. Connect the burner by means of a rubber tube to a point near to the supply to the burner which is being adjusted.
2. Light the burner and observe the flame.
3. Light the appliance burner and adjust it so that each flame matches the flame of the matching burner; thus, if the inner cone of the matching burner is one-third of the total height of this flame, the flame of the appliance burner should be so adjusted that its cone also is one-third the total height of the flame.

It is emphasised that the actual height of the flame of the appliance will not, in general, be the same as that of the flame of

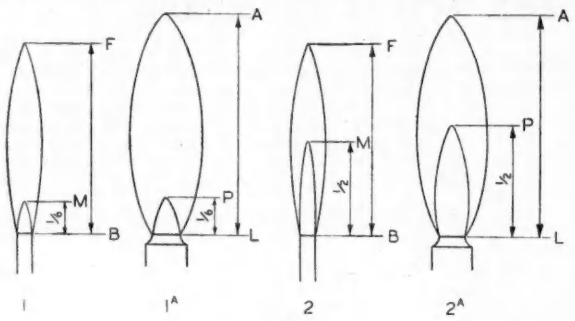


Fig. 4

the matching burner. If, however, the proportion between the cone height and the total height of the flame in each case is the same, then the appliance is correctly adjusted.

In Fig. 3 the appliance flame is shown side by side with the flame from the matching burner. Both burners are being fed from the same gas supply. If the cone height MB is measured and compared with the total flame height FB it will be seen, in this case, that MB is one-third of FB.

Now measure the cone height PL of the appliance burner and the total height AL of the flame. Here again the cone height PL is one-third of the height AL. The appliance burner has been correctly adjusted. If PL were not one-third of AL, then the appliance would have to be adjusted.

If the gas had been 'hard' on the particular day, the flame of the matching burner might have appeared somewhat as shown at 1 (Fig. 4). Here the cone height MB is only one-sixth of the total flame height FB. The appliance flame must be adjusted as shown at 1 . Here again the cone height PL is only one-sixth of the total flame height AL and the appliance is correctly adjusted.

Again, if the gas had been 'soft' on the day in question, the flame of the matching burner would have appeared somewhat as shown at 2 (Fig 4). Here the cone height MB is one-half the height FB. The appliance must therefore be adjusted as shown at 2A, where it will be seen that PL is one-half AL.

For those who prefer a more general statement the relationship to be established for correct adjustment is that:—

$$\frac{MB}{FB} = \frac{PL}{AL}$$

In the case of certain appliances, however, correct adjustment cannot be secured by following the above procedure, since the required ratio between the cone height and total height of the appliance flame differs from that which would be obtained from the flame matching burner operating on the same gas. In such cases specific instructions must be given to the fitter regarding these appliances. Two examples of modern fires serve to illustrate the method of procedure for these appliances.

High Beam Fires

Carry out operations 1, 2 and 3 as above and then reduce the height of the inner cone of the appliance flames by *one-third*. This adjustment will not appreciably affect the total height of the appliance flame, but the cone height will only be two-thirds of what it was when the appliance flame matched that of the matching burner.

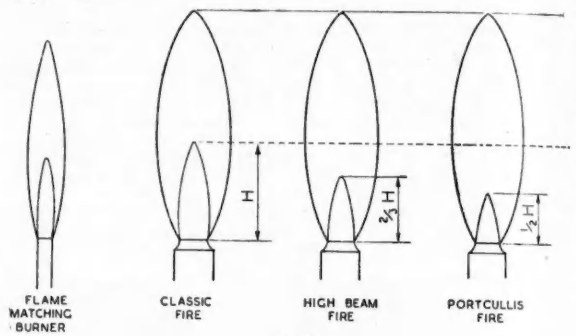


Fig. 5

Portcullis Fires

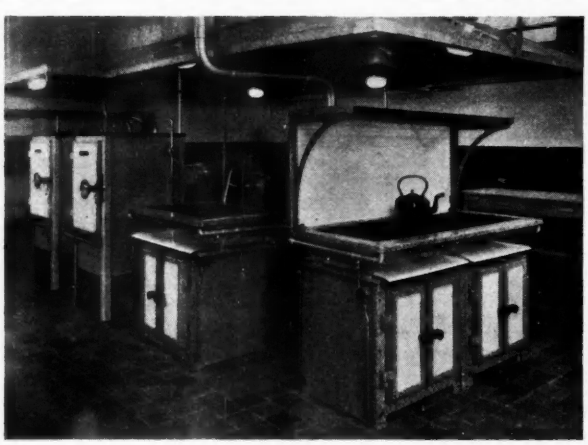
Carry out operations 1, 2 and 3 as above and then reduce the height of the inner cone of the appliance flame to *one-half*.

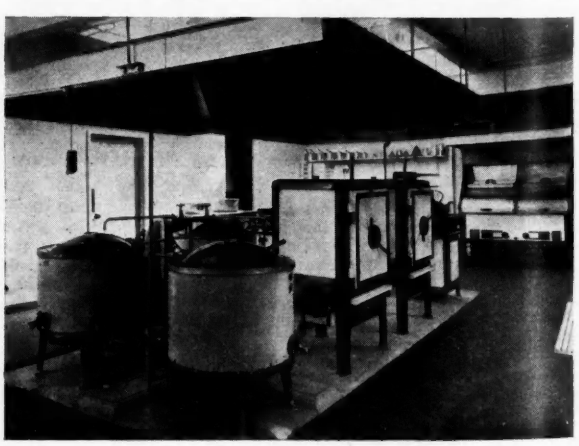
The following illustrations should prove helpful.

Fig. 5 illustrates the special method to be applied in the case of the High Beam and Portcullis Fires.

In the case of burners with fixed injectors and no aeration control, although no adjustment is possible other than the normal cleaning of the burner and injector, it is useful, however, to compare the appliance flame with that of the matching burner.

It is important to note that the flame matching burners used by any particular undertaking must be so constructed that they give flames having cone heights one-third of the total flame height when burning the 'normal' gas distributed by the undertaking.





The London County Council has opened several Civic Restaurants employing a large number of modern gas appliances in their kitchens. On the left is a picture of the kitchen at 'The Gilpin,' Stoke Newington High Road, where the seating capacity is 165. On the right is the kitchen at 'The Drayton,' Drayton Park, Islington, where the seating capacity is approximately 250.

AN ANALYSIS OF THE DOMESTIC LOAD*

(*Continued from page 438*)

THE position in regard to appliances in use by prepayment consumers may be gauged from Table 1. They represent the various combinations of apparatus among the 900,000 households on prepayment supply in the Gas Light and Coke Company area, and may be taken as typical. These figures are averaged for all households, regardless of size, and show that 41.5% have only a cooker or apparatus providing an even smaller load, and a further 10% have cooker and lighting. Thus, over one-half can be said to make the minimum use of gas.

TABLE 1.—*Showing Combinations of Apparatus Comprising the Gas Light and Coke Company Prepayment Load in* 1947.

Apparatus	Percentage of supplies	Percentage of consumption	Average annual consumption per consumer (therms)
Cooker only	30.5	27.0	112.0
Cooker and wash-boiler	11.0	12.5	143.0
Cooker and lighting	10.0	10.5	128.5
Cooker, wash-boiler and fire	4.0	5.0	163.0
Cooker and bedroom fire	3.5	4.0	134.5
Cooker and bath water heater	2.0	2.0	144.0
Cooker and living-room fire	2.0	2.0	131.5
Cooker and sink water heater	1.5	1.5	144.5
Cooker and multi-point water heater	1.0	1.5	177.5
Cooker, sink heater and wash-boiler	1.0	1.5	167.0
Cooker, bath water heater and fire	1.0	1.0	172.0
Cooker, bath water heater and wash boiler	1.0	1.0	158.5
Cooker, sink water heater and fire	0.5	1.0	164.0
Cooker, multi-point water heater and fire	0.5	0.5	206.5
Cooker and other combinations of appliances	19.5	24.5	156.5
Total of consumers with cookers	89.0	95.5	
Hotplate only	2.0	1.0	65.0
Bath water heater only	2.0	0.5	35.0
Other appliances without cooker	7.0	3.0	62.5
Total of consumers without cookers	11.0	4.5	
	100.0	100.0	

900,000 complete households :
- 11.0% of the consumers have apparatus producing on average below 100 therms per annum
- 60.5% of the consumers have apparatus producing on average between 100 and 149 therms per annum
- 28.0% of the consumers have apparatus producing on average between 150 and 199 therms per annum
- 28.0% of the consumers have apparatus producing on average between 150 and 199 therms per annum
- 0.5% of the consumers have apparatus producing on average between 200 and 249 therms per annum

The consumptions obtained when the consumers are classified according to the number of persons in the household, regardless of the apparatus installed, are shown in Table 2, and indicate the diminishing effect of additional persons in the household.

TABLE 2.—*Showing Numbers of Persons in Households Comprising the Gas Light and Coke Company Prepayment Load in* 1947.

Number of persons	Percentage of supplies	Percentage of consumption	Average annual consumption per consumer (therms)
One person	10	5	60.0
Two persons	24	19	98.5
Three persons	25	24	128.0
Four persons	21	24	146.5
Five persons	11	13	168.0
Six persons	5	8	192.5
Seven persons	2	3	210.0
Over seven persons	2	4	238.5
	100	100	

TABLE 3.—*Showing Numbers of Rooms in Dwellings Comprising the Gas Light and Coke Company Prepayment Load in* 1947.

Number of rooms	Percentage of supplies	Percentage of consumption	Average annual consumption per consumer (therms)
One room	4	2	61.0
Two rooms	14	10	94.5
Three rooms	29	28	122.5
Four rooms	21	24	144.5
Five rooms	20	23	149.5
Six rooms	9	11	151.5
Over six rooms	1	1	172.5
Communal bathrooms	2	1	34.5
	100	100	

* From a Report of the Institution of Gas Engineers at the Congress of the International Gas Union.

When the consumers are classified according to the number of rooms in the dwelling, again taking no regard of the apparatus installed, as shown in Table 3, it is seen that the effect of additional rooms is smaller than the effect of additional persons, and is largely determined, in any case, by the fact that more rooms generally imply a large family.

Council Housing Estates

The importance of securing as much of the available load as possible in new housing is apparent. Not only are the tenants often consumers whose consumption in their old homes is lost through clearance schemes, but also the potential load is much greater than that normally obtainable in older properties. In this field, through the valuable co-operation of 30 undertakings in England, Scotland and Wales, which have conducted surveys for the purpose of this report, a great deal of information has been collected which is indicative of past results and future prospects.

The effect of persons in the household, rooms in the dwelling, and of installed apparatus, which has already received attention in connection with the load analysis undertaken by the Gas Light and Coke Company, is apparent throughout the samples, but by extending the range to cover all parts of the country the equally important effects of climatic conditions and the price of gas, not ascertainable in examples draw from a single undertaking, can be considered.

Council housing varies in type, design and equipment from area to area, the permanent dwellings being designed by the architect of the council in question to suit the locality and the class of tenant. Among the older estates a very prevalent combination of gas apparatus is a cooker and wash-boiler, either alone or in association with a coal-range. A group of 15 estates, generally comparable in the main features, with gas cooker and wash-boiler, and without a coal-range has been taken with a group of 12 estates having similar gas apparatus, but with a coal-range in addition. The estates comprising these groups are scattered all over Britain, and, of the 27 included, one was built before 1914, two since 1945, and the remainder between the wars.

The average consumption of all houses in each group taken separately was 160 therms a year, suggesting, as was specifically stated by some undertakings, that when gas is available the majority of householders do not use solid fuel for cooking and water heating. In individual cases, however, it appeared from the quarterly load curve that the coal-range is used in cold weather on account of its space heating properties.

Geographical Groups

In order to study the weight of the geographical and price factors in determining the annual load of this type of consumer the data available were sifted out to extract three and four person households without coal-ranges. Four geographical groups conforming to the requirements were available, consisting of:—

(1) Five estates in Eastern, Southern and South-eastern England.
(2) Three estates in the West Midlands of England.
(3) Five estates in North-western England.
(4) One estate in North-eastern Scotland.

One sample of the 15 originally considered had to be omitted owing to a material difference in the number of persons comprising the household.

The average load for the three to four person households in each of the English groups was 140 to 141 therms, a surprising and unexpected uniformity. (The average is some 20 therms below that per household for the complete estates, owing to the existence of some extremely large households in the general range, particularly in the older dwellings.)

It was found that the average consumption of the consumers in question in 11 out of the 14 individual estates making up the groups fell between 130 and 163 therms a year, but that two cases were substantially below, at 102 and 73 therms a year, respectively, while one was substantially above, at 221 therms a year. The highest figure came from the single Scottish undertaking, but among the English undertakings there was at first no clearly defined regional difference. In fact, the north-western group produced the three lowest, one intermediate and the highest English consumption averages.

Upon relating these results to price a more interesting picture was presented, for both in North-western England and also in Eastern, Southern and South-eastern England, low consumption coincided with high price, high consumption with low price. In

the West Midlands the three examples were at a uniform rate of charge and the consumption range did not vary greatly, while no comparison was possible in Scotland, where the single example produced an exceptionally high consumption at a moderately low price.

The North-western area was the most interesting in that the greatest variation was found both in price and consumption, a figure of 15.0d. per therm producing 73 therms per annum, 11.6d. per therm in three different towns producing a range from 102 to 152 therms per annum, and 9.0d. per therm producing 163 therms per annum.

A further enquiry upon these lines was pursued in respect of prefabricated houses of standard design, equipped with a standard range of apparatus. Those considered were four-roomed houses with a gas cooker, refrigerator, and wash boiler, electricity or solid fuel being used for water heating and space heating. Seven estates, all in England, were taken, but these were in very differing areas, three being in different towns in the Home Counties, one in the south, one in East Anglia, one in the West Midlands, and one in the North-east Coast industrial area. Of these, five produced an average consumption ranging between 151 and 161 therms a year, but two were substantially lower. In one of the latter it was ascertained that the refrigerators were not installed for much of the period, while in the other there has been much dissatisfaction at the rents charged by the Council. These factors, it must be presumed, have contributed to the subnormal results.

These results are interesting in assessing the results of standardisation of appliances, for while considerable uniformity was achieved it is clear that from time to time disturbing factors will be found.

Importance of Local Conditions

That the local conditions are important is obvious, and the following factors have been found in specific cases to influence the level of consumption upwards or downwards in comparison with the average loading anticipated from a given class of supply. The inclusion in a household of members on shift work, requiring out-of-course meals, will increase the cooking load by upwards of 20 therms a year. The inclusion of members of the household employed on dirty work will correspondingly increase the consumption for water heating. Where conditions of employment require food to be taken away from home, consumption will be lower than where the mid-day meal is eaten at home. Where average earnings are low there is a tendency to reduce consumption, and this applies also to where the estate is so situated that members of the household going to work have to spend an appreciable weekly sum on travelling. (This is a most important factor in housing today, where a great deal of building takes place on the outskirts of, and sometimes at some little distance from, the town.) When domestic customs have been taken into account it is the price of gas in relation to the available *net* income of the household which determines the results.

Exceptions will always occur among estates as among individual consumers, but on average there is a clearly definable pattern running through all the results, as seen in Table 4.

TABLE 4.—*Average Consumption of Gas for Various Types of Dwellings on Council Housing Estates in England, Scotland and Wales in* 1947.

Persons in household	Prefabricated houses Cooker, wash-boiler, refrigerator (therms per annum)	Permanent houses Cooker, wash-boiler (therms per annum)	Permanent houses Cooker, wash-boiler, fire (therms per annum)
One or two persons	118	97	121
Three persons	141	135	145
Four persons	145	178	195

These figures show the average consumption for estates taken throughout Britain for families of various sizes with three different combinations of equipment. In the case of the prefabricated houses the limitation of the upward development of the load by the standardisation of equipment will be noted, but otherwise the effect of the number of persons in the household is very clear.

Extension of Water Heating

In future business an extension of water heating may well prove to be an important additional load having favourable seasonal characteristics. Two modern estates in South London, supplied by the South Metropolitan Gas Company, for example, in which multi-point water heaters are installed together with cooker and bedroom fire, give for two-person households a consumption of 213 therms per annum, for three persons 238 therms, for four persons 251 therms and for five persons 281 therms, results which indicate what can be achieved in new housing projects.

Regarding council estate supplies as a whole it should be said in conclusion that the securing of the business is determined not only by the price of gas (although this is, of course, important), but even more by the cost of carcassing and of providing and installing the apparatus. In dealing with 'free' consumers, apparatus prices and fixing charges are often, as has been seen, an absolute deterrent because neither the consumer nor the landlord will find the capital sum required; in council housing this difficulty is not present in so acute a form; a certain standard of amenity has been decided upon as desirable (a standard usually well above that enjoyed by 'free' consumers of restricted income) but the closest scrutiny will be given to costs, and a price favourable in comparison with that of alternative fuels is essential if the load is to be secured for gas. This point cannot be over-emphasised, for, with the apparatus installed the gas will be burnt; without the apparatus there is no load.

Middle-Class and Well-to-Do Homes (The Credit Load)

The domestic credit load is in general built up of the consumption of households somewhat better off than those falling within the prepayment classification, and as a result whatever the size of dwelling the average load will usually be higher. The results achieved, however, are affected by the inclusion of two distinct types of consumer, the middle-class and the well-to-do, and the gradations of income will materially affect the results.

TABLE 5.—*Consumptions of Gas by Prepayment and Credit Users, According to the Numbers of Rooms Occupied, in the Gas Light and Coke Company Area in* 1947.

Rooms in dwelling	Prepayment (therms per annum)	Credit (therms per annum)
One rooms	61	89
Two rooms	95	102
Three rooms	123	133
Four rooms	144	160
Five rooms	149	157
Six rooms	151	158
Seven rooms	172*	221
Eight rooms	—	309
Over eight rooms	—	469

* Seven or more rooms are grouped in the case of prepayment supply.

TABLE 6.—*Combinations of Apparatus which Consumed the Gas Credit Load in the Gas Light and Coke Company Area in* 1947.

Apparatus	Percentage of supplies	Percentage of consumption	Average annual consumption per consumer (therms)
Cooker only	19.7	11.8	108*
Cooker, one other main appliance, and fire or fires	10.3	13.5	234
Cooker, two or more appliances (miscellaneous) and one fire	8.7	8.8	184
Cooker and two or more main appliances (no fire)	7.6	10.7	257
Cooker and wash-boiler	6.3	4.1	119*
Cooker and one other main appliance (no fire)	6.1	4.9	143
Cooker, two or more appliances (miscellaneous) and two fires	5.6	7.6	244
Cooker, two or more appliances (miscellaneous) and three or more fires	5.1	12.4	435
Cooker and one fire	4.6	3.7	133
Cooker and poker	4.1	2.8	125
Cooker and bath water heater	2.8	2.2	145
Cooker and refrigerator	2.8	2.1	134
Two or more appliances other than cooker or fire	2.7	1.7	114
Cooker and multi-point water heater ...	2.6	3.1	219
Cooker and two fires	2.6	2.7	184
Fire or fires alone or with one or more appliances other than cooker	2.4	1.8	136
One appliance other than cooker or fire ...	1.7	0.5	48
Cooker and four or more fires	1.6	2.7	304
Cooker and sink water heater	1.5	1.3	150
Cooker and three fires	1.2	1.6	255
	100.0	100.0	

270,000 complete households:

1.7% of the consumers have apparatus producing on average below 100 therms per annum
51.5% of the consumers have apparatus producing on average between 100 and 149 therms per annum
12.8% of the consumers have apparatus producing on average between 150 and 199 therms per annum
18.5% of the consumers have apparatus producing on average between 200 and 249 therms per annum
8.8% of the consumers have apparatus producing on average between 240 and 299 therms per annum
1.6% of the consumers have apparatus producing on average between 300 and 399 therms per annum
5.1% of the consumers have apparatus producing on average over 400 therms per annum

Note.—On credit supply it is frequently the case that a cooker only is required in flats in which the mid-day and evening meals are habitually taken at restaurants, the cooker being used solely for breakfast and occasional meals. The inclusion of such supplies depresses the consumption of the group. The cooker and wash-boiler combination is largely confined to certain outlying housing estates of small lower middle-class houses, and the total consumption is depressed by economic factors.

In the figures for the Gas Light and Coke Company, given in Table 5, the incidence of the 'luxury' flat, particularly in the four-room group, increases the demand, which subsequently falls

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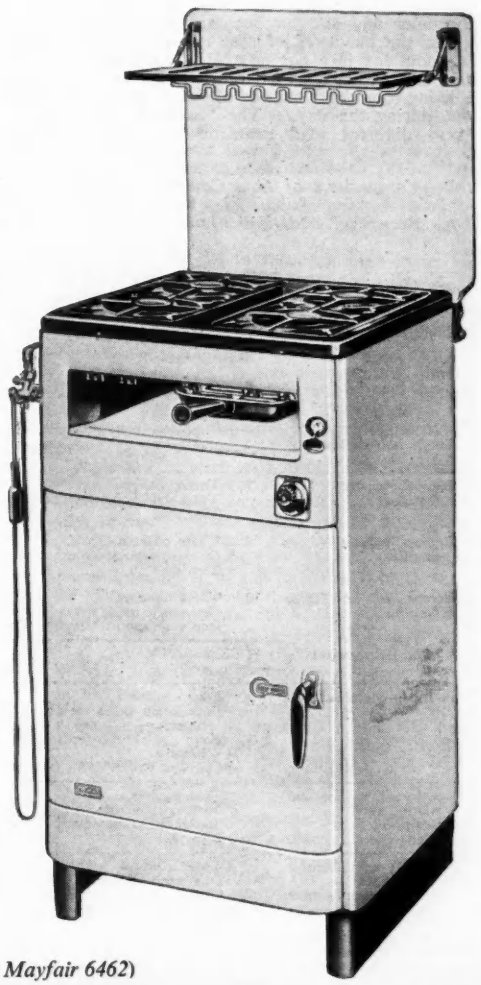

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away as this type of consumer gives place to the suburban household in the five-and six-room class. Then, with a larger number of rooms the proportion of well-to-do households again increases, and consumption jumps up to very high figures in the case of the rich man's town house. In comparing the consumption of the one-room consumers on prepayment and on credit supply allowance must be made for the depression of the former by the inclusion of a high proportion of the very poor, while the credit load is for the most part that of business people living alone, who are better able to pay for all the comfort required in so moderate an establishment.

Significant Differences

The most significant difference between the credit and the prepayment demand lies in the seasonal load characteristics. This is due in part to the difference in income, with a consequent greater demand for comfort on the part of the former, but also to the fact that the ratio of persons to rooms among credit consumers is very much lower, with a consequent scaling up of the space heating content of the load in relation to the remainder; on the other hand lighting is virtually absent. Table 6 gives the principal apparatus combinations present in a large sample of Gas Light and Coke Company credit consumers, and may be compared with the similar analysis for the prepayment load in Table 1. Owing to the much wider range of apparatus it has been found desirable to group the results in a somewhat different way.

While the base load of the credit consumers tends to be proportionately greater than that of the prepayment consumers, in similar sizes of household, the apparatus larger and its range more extensive, it is the additional number of fires which makes the significant difference, and the variation in usage between one consumer and another becomes very marked. This is on account of the incidence of the 'leisure' factor. For example a living-room fire in a flat occupied by a single elderly lady and her maid may produce a far larger winter load than a similar fire in the living-room of a family whose members are for the most part out during the day. The 'luxury' flat and the mansion have very different load characteristics from the middle-class home.

TABLE 7.—*Comparison of Gas Consumption Loads in* 1947 *in a London Suburb in Which Large Houses Have Been Converted into Flats and/or Business Premises.*

Example	Occupancy	Total number of persons living in building	Total amount of gas apparatus	Annual consumption in building (therms)
A	Single household	3	One cooker One refrigerators Six fires	362
B	Single household	5	One Cooker One refrigerator One fire	590
Average	Single households	4		476
C	Rooms sub-let (three families)	7	Three cookers Two single-point water heaters Two fires	774
D	Rooms sub-let (three families)	8	Three cookers One single-point water heater Two fires	392
E	Rooms sub-let (three families)	18	Three cookers One single-point water heater One multi-point water heater	596
Average	Sub-let premises	11		587
F	Four self-contained flats	9	Four cookers Four single-point sink water heaters Four single-point bath water heaters One gas poker	1,036
G	Dentist with surgery and waiting room One sub-let flat		Two cookers Two refrigerators Two multi-point water heaters Five fires	888
H	Brush manufacturer (staff of six) Gown manufacturer (staff of five) Carpenter's shop Each with domestic premises attached		Three cookers One wash copper One single-point water heater One drying cabinet Four fires	2,052

The Splitting Up of Large Houses

The trend towards the splitting up of large houses is increasing under the conditions of today, and as an example of the effect the load of eight such houses in a single street in an inner suburb of London as shown in Table 7. The different loads attained in different circumstances are of interest as being indicative of the demand placed upon the undertaking by such changes.

Waiting-Rooms, Surgeries, Small Shops and Offices

The domestic load is sometimes combined with a non-domestic load carried on in the same premises by the householder. This generally takes the form either of the professional man's requirements in rooms used as offices, waiting-room, or surgery, or of the shopkeeper's requirements in his shop. In either case space heating provides a major part of the demand.

Where waiting rooms and surgeries of doctors and dentists are separately metered they are found to provide a substantial load, that in the Gas Light and Coke Company area averaging 389 therms per annum, of which 262 therms, or 68% were taken in the six winter months. The load curve of small shops and offices showed similar seasonal characteristics, though the total demand per consumer was very much less, averaging 184 therms, of which 127 therms (70%) were taken in the winter months. These loads are, of course, independent of the gas used in the domestic part of the premises, which will follow the usual pattern according to the size of the household and the apparatus installed.

The Quasi-Domestic Load

The quasi-domestic load dovetails into the pure domestic load at a number of points, for it is no more than an extension of the latter on a communal scale.

The development of the modern block of flats has necessarily focussed attention on the provision of central services, initially in the high-priced 'luxury' type of dwelling, but subsequently in council housing schemes also. The principal services which may be provided are hot water, central heating and restaurant facilities, with communal wash-houses in working-class flats, and each of these provides an opportunity for extended use of gas. There is, however, no universal trend in this direction, for in very many cases individual equipment in each flat is provided for some or all of these purposes. Where the self-contained flat, with its own services, is preferred, a serious obstacle to the use of gas may be found in the suppression of flues in the modern type of structure, while a new competitor in the form of district heating is already in the field, though at present handicapped by the extremely high capital cost.

In the provision of central services the hot water and central heating loads are usually classed together, although the load characteristics of each differ considerably, the one being a base load, the other seasonal. As a matter of common practice, the two are met from the same equipment, and it is difficult to differentiate between them, so that, according to the actual installation in each case, the demand may range from the relatively steady all-the-year-round requirements of domestic hot water to the purely seasonal requirements of space heating, with the two combined in various proportions in the intermediate stages. Naturally, the former provides the most attractive proposition for the undertaking, but it is, generally speaking, commercially inexpedient to demur at the inclusion of the latter.

It is but a small step from the centralised installation in a single large block of flats to the zonal scheme, by which similar services are provided from a single point for a small group of separate houses or small block of flats, and from this to the district heating scheme proper. Attention has been paid to the possibilities of these from the point of view of the use of gas, but as yet there is no important development to record. Another branch of the quasi-domestic load catering, for where meals are not cooked at home they must be taken in some form of catering establishment, and in this direction the gas industry continues to make very good headway.

Effects of Social Changes

As in the domestic field, in catering the recent social changes have had their effect, and whereas before the war the bulk of the business lay with restaurants the snack bar today offers a rapidly developing load. In London, for example, snack bars now provide an increasing proportion of the mid-day meals of shop and office workers, having to some considerable extent supplanted the restaurant on the score of cheapness and speed of service. A parallel development is that of the canteen, both in large shops and offices and, on a greater scale, in factories and workshops. These loads are level in character, except for a slight recession in the holiday period, although in the case of factories with a fluctuating pay-roll the load will also move proportionately to the number of employees. There is no doubt that both the snack bar and the works and office canteen will remain a permanent feature of the catering load, and that for some time to come the number of such supplies will show an increase.

Catering business at seaside resorts shows a different load characteristic from that in inland cities and towns; in the former case the influx of summer visitors provides a peak demand in that season. Results from Southend-on-Sea have been studied, a town which provides both permanent residential and a summer seasonal business, and it is found that whereas in what may be

termed the first-class restaurants the load is relatively steady throughout the year, in the second-class restaurants and to an even greater extent in the snack bars there is a decided summer peak.

School canteens provide a developing business with a load contour peculiar to themselves. The demand is steady and substantial during term time, and disappears altogether during the Christmas, Easter, and summer holidays.

Clubs and Hotels

Another type of business having a high loading, which is probably peculiar to central London, is the West End club, which provides a demand including both catering and central services. In this case consumption is steady throughout 10 months of the year, but falls away rapidly during the period from mid-August to the end of September, when the clubs close for holidays and re-decoration.

Finally there is the hotel business, which ranges from the small boarding-house and hostel upwards to the large luxury hotel in the West End of London. The load of the former group tends to include a large proportion of space heating, due to the use of gas fires in bed-sitting rooms, while as the size of the establishment increases this space heating demand may decrease with the provision of central heating from solid fuel, and the catering demand grows. Thus the load characteristics improve.

It is not proposed in this report to deal with the industrial gas load. The use of gas for specialised processes is a highly developed side of the business requiring expert knowledge and the use of specially designed apparatus. The factors controlling demand bear little or no relation to those influencing the domestic and quasi-domestic loads, and consequently the two problems cannot be approached in the same way. It is hoped, however, that the analysis of the domestic and allied business which has been outlined here will have proved of some value not so much in providing a solution to the problems of supply as in indicating a method of isolating these problems in order to assist those responsible for commercial policy. One thing is abundantly clear—namely, that the demand for the services that gas can give is very far from being saturated in any field; but under competitive conditions the watchword is 'know your load.'

The Council of the Institution of Gas Engineers desires to express its thanks to the Governor and Court of the Gas Light and Coke Company for permission to make full use of the Market Research records of that Company, and to the managements of the 30 undertakings in England, Scotland, and Wales, which, at considerable trouble to themselves, supplied the data used in the section dealing with council housing estates.

Its grateful appreciation is due to Mr. Stirling Everad, M.B.E., Manager of the Market Research Section of the Gas Light and Coke Company, who prepared this report; to Mr. J. A. Reece, his statistical officer, and other officers of the Company, and to the Market Research Section for their team work in preparing the very large amount of statistics required.

F.B.I. AND THE ECONOMIC CRISIS

A CALL FOR EFFORT AND SACRIFICE

THE Grand Council of the Federation of British Industries has issued a statement expressing concern at the inadequate appreciation of Britain's economic situation. 'We are now in grave danger,' it says, 'of being unable to obtain the food and raw materials that we need; we shall soon have to face further austerity and unemployment, unless some solution to our difficulties is found.'

The country is confronted with two interlocking problems. In the first place it shares with many other countries in a shortage of dollars to buy from America and Canada the goods which only they can immediately supply. Marshall Aid has been designed to fill temporarily the gap between these imports and the European and other exports which directly and indirectly go to pay for them, and it was hoped that by 1952 Britain would be self-supporting. It has become clear that our reserves are being spent too rapidly. Great Britain is the banker for the whole sterling area, with the advantages and the responsibilities that this fact involves. Our reserves are now reduced to 20% below the lowest margin of safety. Palliative stop-gap measures are being imposed by the various Governments concerned, pending the Conference at Washington in September. Nobody, however, suggests that these measures provide a permanent solution.

Balance of Payments

Britain is particularly vulnerable as it has to import 60% of its food and a great deal of its raw material. We are therefore faced with the problem of paying our way (with temporary help in dollar markets) in our international trading with all other countries (including dollar countries). In 1948 we achieved this balance, but only under abnormally favourable conditions. It is doubtful if we are doing so today. Moreover, a large part of the credit side of the balance consisted of exports made in payment of wartime debts, and therefore not available to buy the imports we currently needed. To that extent the balance was unreal. The payment for current imports must come from yet more exports sold under normal competitive conditions. Irrespective of the dollar gap we must put ourselves in a sound trading position with the rest of the world.

It is our visible exports from productive industry, together with the invisible exports arising from the whole machinery of trade, including the services rendered by Shipping, Industry, Banking and Insurance, that must pay for the imports of food and raw materials; and there can be no escape from the hard logic that our standards of living, including social services, must be cut according to the cloth we can from now on make.

Domestic Policy

The statement asserts that we are still living beyond our means. Increase in State expenditure constitutes the basic inflationary influence in our whole economy. It is this which bears most heavily upon production costs and is one of the most serious handicaps to the future of British trade and to the living standards and employment of our people. Now that we have passed from the seller's market of recent years, the dangers of living beyond our means, with its corollary of high and crippling taxation, will be felt.

The re-establishment of Western civilisation must come from the co-operation of many nations on both sides of the Atlantic. Great Britain as a world power has a special responsibility to play its part. Unless she earns it, she has no right to expect a higher standard of living than her neighbours. Unless she earns it, she will not long maintain the standard that she now enjoys. This is emphasised by the evidence that is now accumulating that in fact she is believed by other countries to be attempting to achieve too quickly what she can no longer afford. The savings of past generations have been spent in the war. Future prosperity depends on present effort.

One thing is obvious: we must as a nation pay our way. This depends on productive industry, supported by the trading and other services that earn our invisible exports. There is therefore the plainest necessity to give every encouragement to it. In the competitive conditions that are increasingly to be expected it is essential that every help be given in reducing costs of our exports: value for money alone will enable us to sell in overseas markets.

Taxation and Government expenditure must come down. At present the tax gatherer collects 8s. out of every £ that the nation produces. Profits are taxed even more heavily than this, and no opportunity is left to create adequate reserves. The high taxation which we now bear is itself a direct cause of high costs. The rigidity of the planning of our economic life should be relaxed. Controls have been reduced in number, but more could be abandoned. Price mechanism will, as it has in the past, apply the necessary correctives. The spur of competition is still the most effective aid to efficiency.

We must face the fact that as a nation we must work harder without increasing costs of production. We must concentrate on the things that matter. Such schemes as the nationalisation of iron and steel are irrelevant to our present crisis, distracting to those who should be concentrating on production and marketing problems, and damaging to our future prospects. Everyone engaged in industry must strain every nerve to cheapen methods of production, to abandon restrictive practices, and to adopt all possible aids to increased productivity.

'This is a programme,' concludes the statement, 'that will demand effort and sacrifice from all. It will not of itself solve our difficulties, but without it no solution can be found. Unless we are prepared as a nation to take such measures as are within our own control we shall not create the confidence in our sincerity that must be the foundation on which international action can be built. These same measures will also help us to bring down the costs of our exports, to hasten the day when we are again self-supporting, and to enable us by our own efforts to bring back prosperity.'

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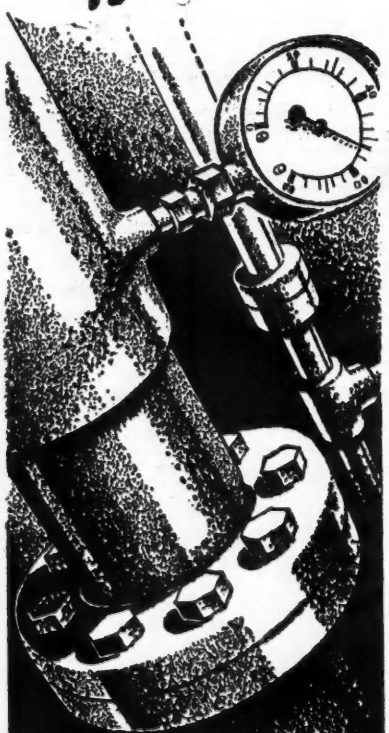

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EIGHTH LIST OF GAS VALUES

Compensation values of 55 securities of 30 companies were listed by the Ministry of Fuel and Power in the eighth list of take-over prices published on Aug. 22, bringing the total of stocks now dealt with to 695. In the following list securities are in units of £100 unless otherwise shown.

Company	Compensation Value
Ashby-de-la-Zouch, 5% Pref.	£112/10/–
Do., Ord.	£185
Associated Gas & Water, 3½% Red. Deb.	£100/10/–
Bedale, Ord. (£1 unit)	20/–
Caldicot, Ord. (£1 unit)	46/–
Calverley & Horsforth, 10% Orig. Ord.	£200
Do., 7% Ord.	£143
Chasetown, 5% Pref. (£5 unit) ...	£5/12/–
Do., Ord. (£5 unit)	£10/5/–
Cheltenham, 3½% Red. Deb.	£100
Do., 4% Red. Pref. (before 1/1/46)	£102/5/–
Colchester, 5% Perp. Deb.	£127
Do., 4% Red. Deb.	£101
Derby, 4% Perp. Deb.	£103
Do., 4% Red. Deb.	£103
Dudley, Brierley Hill, Consol. Ord ...	£121
Gloucester, 3½% Red. Deb. (1961) ...	£100
Do., Consol. Ord.	£122/10/–
Iron Bridge, 6% Basic Ord. (£1 unit)...	29/–
Isle of Thanet, 5% Perp. Deb.... ...	£126/6/8
Do., Consol. Ord.†	£180
Do., Addl. Ord.†	£180
Llandrindod Wells, 6% Red. Deb. ...	£108
Llantrisant, 4½% Mort. Deb.	£104/5/–
Do., 4% Mort. Deb. (1957) ...	£101
Do., 5% Pref. (£5 unit)	£5/12/–
Do., Ord. (£5 unit)	£4/2/6
Long Eaton, 'A' Ord.	£188
Do., 'B' Ord.	£157
Lydney, Ord. (£1 unit)	35/6
March, Ord. (£6 unit) (since 31/12/45)	£12/0/11*
Market Drayton, Orig. Ord. (£10 unit)	£21
Do., Addl. Ord. (£10 unit) ...	£15
Middlewich, 7% Stand. New Ord. (£5 unit)	£10
Mirfield, Ord.	£105
Monmouth, 10% Max. 'A' (£1 unit)...	44/–
Do., 4% Max. 'B' (£1 unit) ...	20/–
Do., 7% Max. 'C' (£1 unit)... ...	31/–
Newbiggin-by-the-Sea, Ord. (£5 unit)	£4/2/6
Newport (Monmouthshire), Consol. Ord.	£195
Newton Abbot, 6½% Pref. (£1 unit) ...	26/6
Do., 'A' Ord. (£1 unit)	32/–
Do., 'B' Ord. (£1 unit)	21/6
Rugeley, 'A'	£145
Do., 'B'	£145
Shotley Bridge & Consett, 5½% Perp. Deb.	£134
Do., 4% Red. Deb.	£101
Do., Consol. Ord.	£104
Stroud, 3½% Red. Deb.	£100
Do., Consol. Ord.	£122/10/–
Swanage, 7% Pref.	£130
Do., 4½% Pref.	£105
Do., 'A' Ord.	£125
Do., 'B' Ord.	£85
Whitchurch (Salop), Ord. (£5 unit) ...	£8

* The value of these securities has been determined by reference to the prices of issue, in accordance with subsections 25 (6) and 25 (7) of the Act. The average value (Section 25 (7) (*b*)) is shewn, and is applicable except where a price of issue (Section 25 (7) (*a*)) determines the compensation value.

† The value of these unquoted securities has been determined in accordance with subsections 25 (10) and 26 (4) of the Act.

TRADE NEWS

New branch headquarters have been opened by **Alder and Mackay, Ltd.,** in Cork. For some years premises were rented at Kyrl's Quay, Cork, and though they were favourably situated they were not sufficiently large to meet the Company's requirements. Recently premises at 46/47, Sheares Street, Cork, have been purchased and modern plant has been installed to ensure a high standard of workmanship in the manufacture and repair of meters. The branch Manager is Mr. D. Hastie, and the telephone number is Cork 166.

* * *

For those interested in welding developments, the 100th issue of *The Welder,* a technical magazine published by **Murex Welding Processes, Ltd.,** Waltham Cross, Herts, contains much that is of technical value. Publication of this centenary number has been marked by a special issue which deals completely with the firm's works and processes. Included in the articles in this attractively produced journal are a description of the research department, which employs metallurgists, chemists, physicists, mineralogists, and engineers, an outline of quality control methods, and the manufacture of extruded electrodes.

* * *

To provide an odourless, stable, and cold-resisting interior fabric for refrigerators and ice-cream conservators, and for use wherever food is stored or served, the Plastics Division of **Thomas De La Rue & Co., Ltd.,** 84, Regent Street, London, W.1, are manufacturing a special grade of their Delaron laminated plastic, in black or white in sheet sizes up to 9 in. by 4 in. in any required thickness. For use in large refrigerating plants in the docks and in food processing factories, this lining is easily cleaned, and has negligible water-absorption. Delaron industrial laminates, in paper or fabric grades, are well-known to the building and allied industries and are widely used for panelling, furniture manufacture, shop-fitting, and the construction of specialised products.

A PONTYPOOL GAS KITCHEN

This spacious gas kitchen, which serves the canteens at the British Nylon Spinners factory at Pontypool, has been equipped by Benham & Sons, Ltd. Its modern equipment was admired by the Duchess of Kent on a recent visit to the factory. The kitchen provides a 24 hours service of meals for the 2,000 people employed at the factory, and is situated between two large canteens—food being served out at each end. Three eight-hour shifts are worked and the kitchen provides a main meal for each shift as well as a continuous service of snacks.

GAS COUNCIL PHOTO